204

# LUMINOUS FOUNTAINS

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WESTINGHOUSE

WESTINGHOUSE ELECTRIC

# The Fountain

So here my fountain flows, loved of
the wind
To every vagrant, aimless gust inclined,
Yet constant ever to its source. It greets
The face of morning, wavering windy
sheets
Of woven silver; sheer it climbs the
noon,
A shaft of bronze; and underneath the
moon
It sleeps in pearl and opal. In the
storm
It streams far out, a wild, gray,
blowing form;
While on calm days it leaps above
the lake—
Pelting the dreaming lilies half awake,
And pattering jewels on each wide,
green frond—
Recurrent pyramids of diamond!

By HARRY KEMP

The fountain in its new glories—enhanced in beauty by harmonious color blends from underwater illumination—a symphony of topazes, emeralds, aquamarines, and carnelians. The fountain illustrated above is a Westinghouse installation at Athens, Greece. The cover illustration shows the cascades and fountains at Washington, D. C.

# LUMINOUS FOUNTAINS

## ★ *General Considerations* ★

MANY are the praises which have been heaped upon fountains in prose and poetry, daylight fantasies inspired by sunlight and shadow. It remains for some modern lyrist to describe the fountain enhanced in beauty by harmonious color blends from underwater lighting. Colored light is definitely established as a tool of art fully as effective as the painter's brush in producing pleasing effects, and with the additional advantage of combining the element of motion with that of color. Few sights are more impressive than a fountain of natural stone in a setting of green or autumn-brown foliage, with concealed lights tinting the streams and falling spray with ever changing colors.

### Water Displays

The individual water forms commonly used, and the methods by which they are obtained, can be divided into five classes, as follows:

1. Solid Jets, over a wide range of heights, produced by smooth-orifice nozzles.

Solid jets may be vertical, either singly or in groups. A number may be placed on a small circle and directed outward, forming a group of plume-shaped forms, or they may be placed on a large circle and directed inwards.

2. Rings of Jets, consisting of small nozzles at intervals of a few inches on top of a circular ring of pipe. When set vertically, the water form is a cylinder. By inclining each jet outward several degrees, an umbrella-shaped form is obtained. When inclined inward to converge at a distance above the ring, the jets are dome-shaped.

3. Straight-Line Jets, are made up like the rings, except that they are set on straight runs of pipe, forming a curtain of water.

4. Cone Sprays, produced by nozzles with spirals or deflectors to give a cone of the required angle. One type of nozzle is equipped with internal spirals of various pitch, giving cones of 30, 45, or 60 degrees divergence. Another type is equipped with external deflectors which are threaded to a stud at the orifice, and shaped to give the desired form.

5. Flat Sprays, having a wider spread in one plane than in the opposite.

### Underwater Lighting

Waterproof floodlights inside the pools of the fountain are most widely used. The light is directed to the jets or sprays and make the water itself luminous. Direct lighting from outside the fountain produces only mediocre results.

The varying characteristics of fountains—with jets and sprays of various heights and forms, with lighting units submerged under water of various depths and degrees of clarity—make

Wilcox Memorial Fountain at Westerly, Rhode Island. The twelve Aqualux floodlights are concealed in the pond by artificial lily pads.

impossible the standardization of lighting design. The wattage, for example, to produce a desired effect varies greatly with the subject and must be determined by past experience under similar conditions. In small fountains space is often the deciding factor; the area available for mounting projectors may be sufficient for only a moderate or even inadequate number of units.

Where colored lighting is used, sufficient wattage should be installed to compensate for the absorption in the color lenses. Limitation of space and cost frequently permit only partial compensation, even so far as allowing the same wattage for the colors as for the white light. In these cases the intensity is of course lower in the color lighting. The average observer, however, is not conscious of differences in intensity, since his attention is occupied by the color display.

### Overflow or Crest Lighting

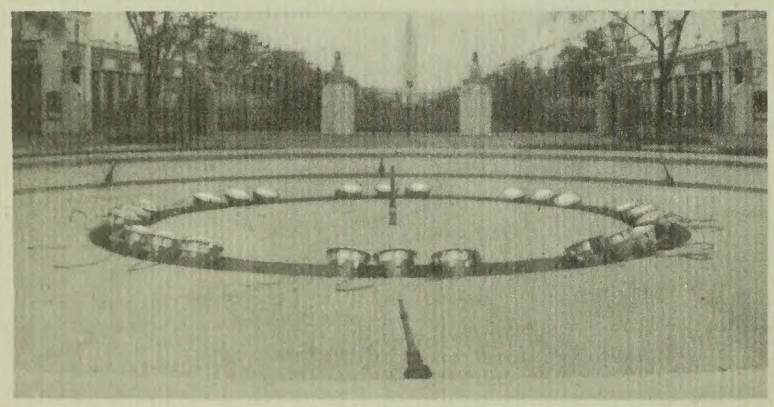
When the fountain consists of two or more basins at different levels, the overflow from the higher basins may be illuminated at little additional expense.

The most satisfactory method of lighting a waterfall is from above, by equipment concealed under the crest. For moderate heights a globe light is satisfactory, while falls over 8 or 10 feet in height require units with specially designed reflectors and lenses to obtain an economical utilization of light. Frequently the crest of the basin and the lighting equipment can be built integral, eliminating the cost of molding concrete to the required contour. The metal crest also gives the required mechanical strength without exceeding the correct proportions with respect to the entire mass, frequently a fault with concrete.

Waterfalls may also be illuminated from below, but the light sources are visible and detract from the general appearance. An important consideration is not only to install enough wattage in each color, but also to space the units sufficiently close to eliminate bright spots under each light and darker areas between.

## ★ Fountain Construction ★

THE designer of a fountain will, of course, evolve a type of construction to conform with his client's ideas and intended expenditure. It is essential, however, to coordinate the design of masonry, lighting and hydraulic equipment, if an economical and conveniently arranged fountain is to result. Lighting is frequently added as an after-thought and produces inferior results that could have been avoided by an earlier consideration of the night display.



View of fountain in process of construction, showing location of underwater floodlights and nozzles.

**Pump**—The water pressure required is ordinarily obtained by a motor-driven centrifugal pump, either single- or double-suction type. Both pressure and water capacity (gallons per minute) must be considered in selecting a pump, and the performance curves supplied by the manufacturer must be consulted to obtain the correct size of pump and the required motor horsepower.

To avoid detracting from the appearance of the landscape, the pump and control equipment are usually placed in an underground vault, preferably under the basin to minimize the length of pipe runs and wiring.

**Water Supply**—A fountain requires only small additions of water from time to time to replace that lost by evaporation and spilling. A float valve in a line connected to an outside supply does this automatically.

The suction line to the pump is connected to the basin, preferably through a strainer with a series of perforated screens graduated in size to stop particles likely to clog the spray jets.

A means should be provided for draining the fountain pool into a cistern or sewer when it is cleaned or closed down. There

Belle Isle Fountain, Detroit, Michigan.

should also be an overflow pipe in the basin.

**Pump Manifold and Pressure**—Each different water effect in a fountain must be supplied by a separate line to permit adjustment of the heights. A pipe manifold is therefore connected to the discharge side of the pump, with a branch line for each water effect.

In each branch line a hand valve is connected for adjusting the jet heights. The pump must be able to produce the maximum pressure water effect, with sufficient allowance for loss in the pipe lines.

**Mobile Water Effects**—The attraction of a fountain having a variety of water displays is greatly enhanced by automatically operating the jets and sprays alone and in various combinations through a predetermined cycle. For this effect an electrically-operated valve is placed in each supply line and controlled by a motor-driven flasher with a contact for each valve.

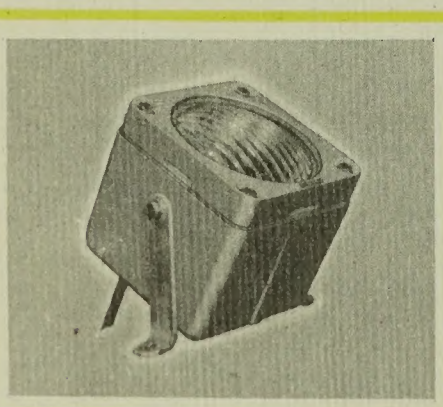
**Piping**—Brass or copper alloy, since it is non-corrosive, is the most suitable material for pipe and fittings. Its longer life will compensate for the increased cost over iron pipe. The run from the pump to the nozzles or spray rings should be as direct as possible to minimize pressure loss in bends. The piping in the basin should be supported at intervals by pipe hangers cemented into the floor, with a slight slope in all pipes toward the pump to provide complete drainage of the hydraulic system when the fountain is to be shut down.

Soldered copper fittings are now available that permit the use of light-gage copper tubing. The fittings are provided with a special solder channel and feed hole. The joint is sealed by heating with a blow torch and applying solder to the feed hole in the fitting, whence it flows to the contact surface by capillary attraction. The elimination of threads thus facilitates installations in which numerous bends and small clearances exist, common enough in fountain installations.

Aqualux Pool type fountain for the distinctive small garden—inexpensive to install and operate, and provides a variety of color lighting effects.

# Aqualux Pool Type Fountain

THE equipment supplied for an Aqualux Pool type fountain consists of lights with supporting legs, nozzle, ring of jets, pump and motor, motor-starter, light contactor, safety switch and flasher. Only the standard pipe and fittings and miscellaneous electrical items are required to complete the installation.



**Fountain Pool**—The fountain requires a pool having a minimum diameter of 20 feet, from which the water is circulated by the pump through the fountain, requiring only a small make-up supply at intervals. If desired, an automatic float valve may be installed in the water supply line to maintain the level in the pool. A screen on the pump suction line keeps foreign matter out of the pipe lines.

**Fountain Basin**—The basin in which the lights and water displays are mounted is 42 inches in diameter and 12 inches deep, with a stone or terra cotta spillway to the water level in the surrounding pool. A drain pipe with cap is installed for draining the basin.

**Water Effects**—The water display consists of a main center jet projecting to a height of 10 to 12 feet and a ring 3 feet in diameter with small jets projecting streams to a height of four feet, turned outward so that the sprays fall just out-

side the basin. If desired, the ring may be constructed with the jets turned inward to form a dome. Each display is supplied by a separate pipe line from the pump vault, the two requiring approximately 25 gallons per minute.

**Color Lighting**—The lighting for the night operation of the displays is provided by four type WF-8 Aqualux floodlights submerged in the basin and supported from the floor. Each is placed on a separate circuit and equipped with clear, amber, red and green lenses and 250-watt, G-30 bulb lamps.

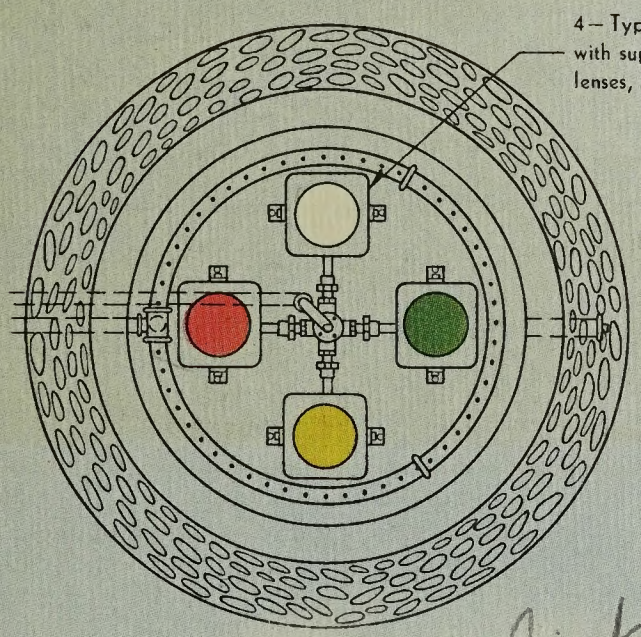
The flasher operates the lights through a 90-second cycle of successive colors, as shown in the cycle diagram below.

**Pump Vault**—The pump and motor, flasher, valves and switches are placed in an underground vault concealed behind shrubbery or trees a short distance from the fountain. Inasmuch as the operation of the fountain apparatus is by remote control from any convenient point, it is unnecessary to enter the vault except for periodic inspection of the equipment.

**Power Consumption**—The average power consumption of the fountain is only approximately 650 watts during the day and 1080 watts at night when the lights are turned on.

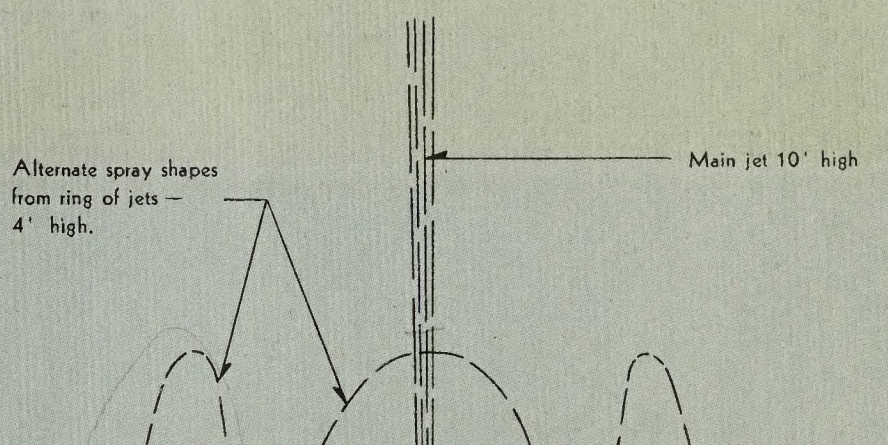
**Time Switch Control**—The operation of the pump and lights may be made automatic by the installation of a two-circuit time switch, which will turn on the pump in the morning, turn on the lights at dusk, and turn both off late at night.

**PLAN**




**COLOR LIGHTING EFFECTS**

1 Cycle = 90 sec.

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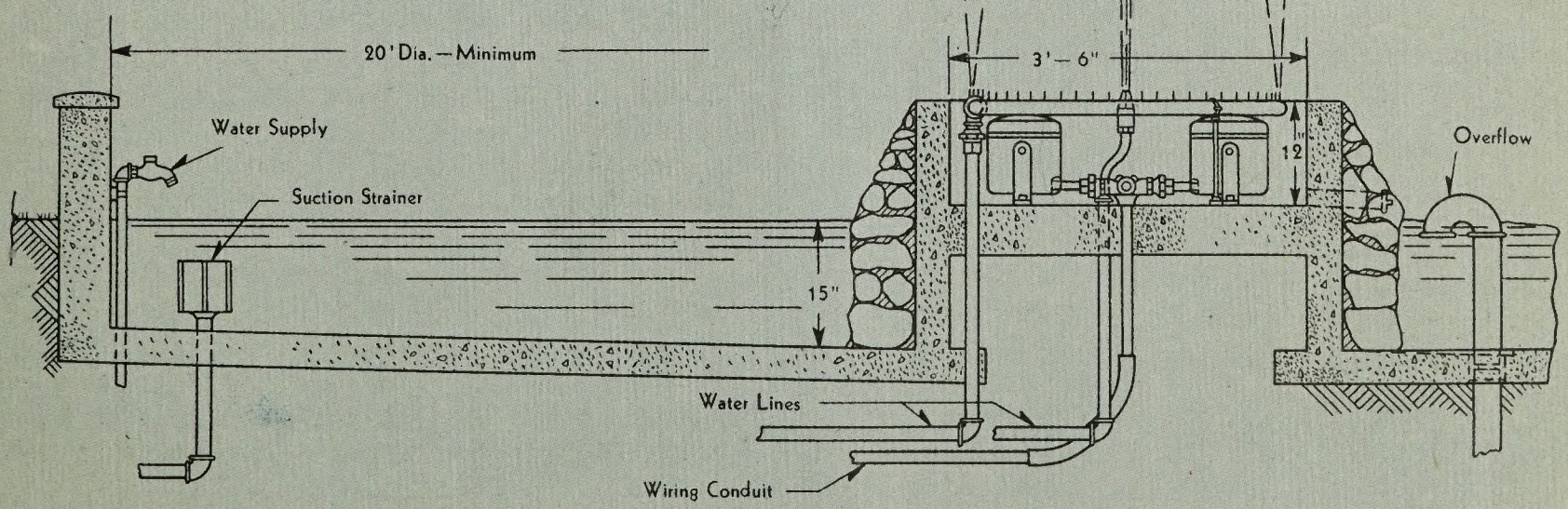
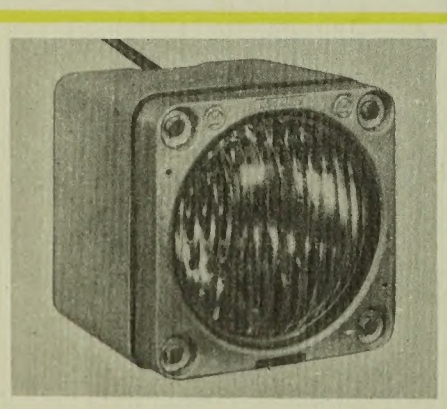
**TYPICAL SECTION**



Aqualux Pedestal type fountain for the modern estate or formal garden—provides a variety of beautiful color lighting and water effects.

# Aqualux Pedestal Type Fountain

THE equipment supplied for an Aqualux Pedestal type fountain consists of a cast-iron basin complete with lights, piping and nozzles, cast-iron pedestal, strainer for suction line, float valve, pump and motor, pump manifold with hand valves, solenoid valves, motor starter, light contactor, safety switch, remote control station and flasher. Only the standard pipe, fittings and miscellaneous electrical items are required to complete the installation. The basin is shipped with lights, nozzles, and piping installed.



**Fountain Pool**—The basin and pedestal are placed in the center of a pool from which the water is circulated by the pump through the fountain, requiring only a small make-up supply at intervals. This is taken care of automatically by a float valve in the water supply line. A screen on the pump suction line keeps foreign matter out of the pipe lines.

**Vault**—The pump, flasher, valves and contactors are placed in an underground vault concealed behind shrubbery or trees a short distance from the fountain.

**Water Effects**—The water display consists of three different effects—a main center jet projecting to a maximum of 30 feet, a ring 4 feet in diameter with small jets forming a dome four to

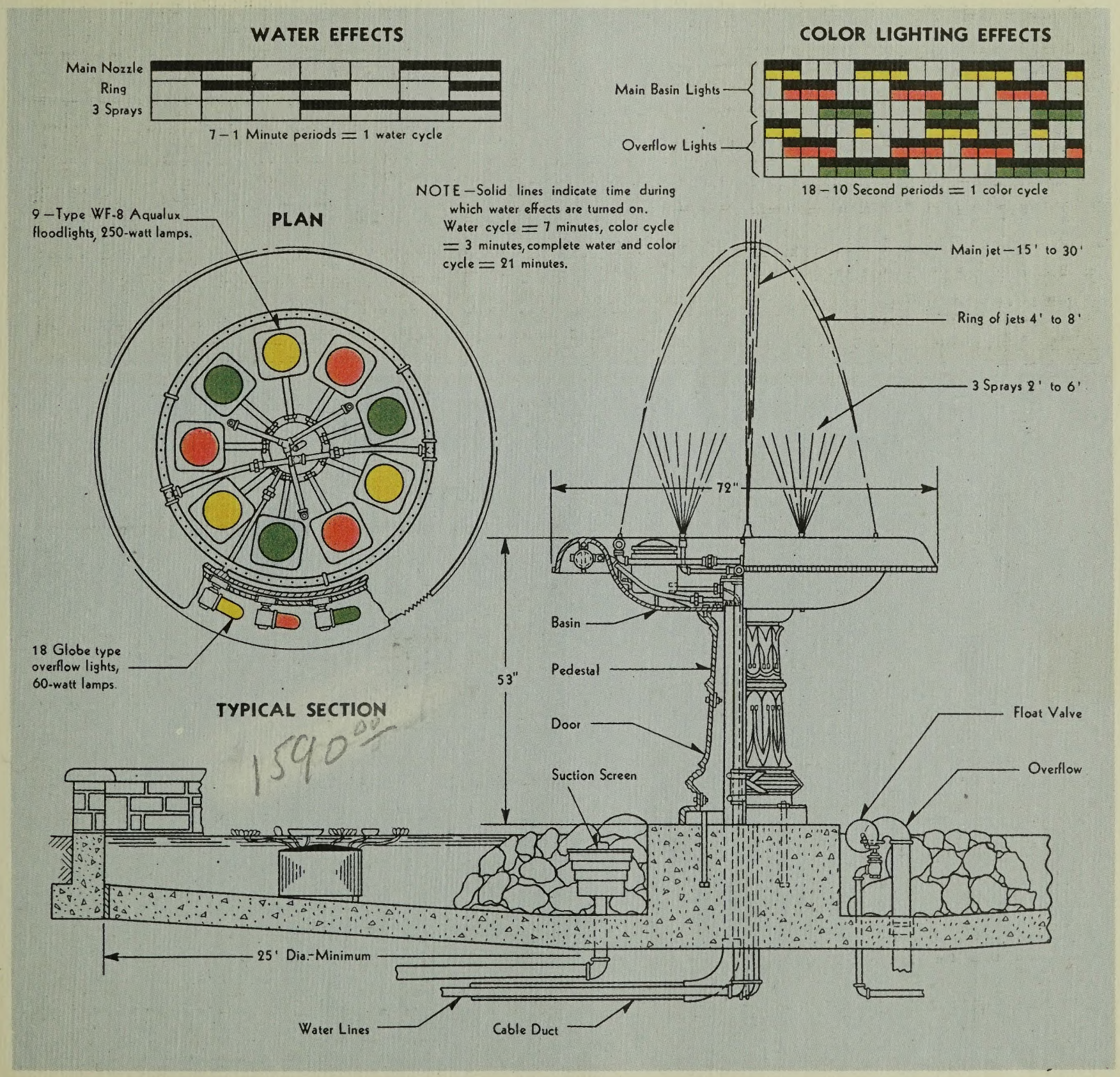
eight feet high, and a group of three nozzles giving hollow cone sprays from two to six feet high. The flasher automatically operates the solenoid valves in a cycle of seven one-minute periods, one or more of the three water effects being on during each period.

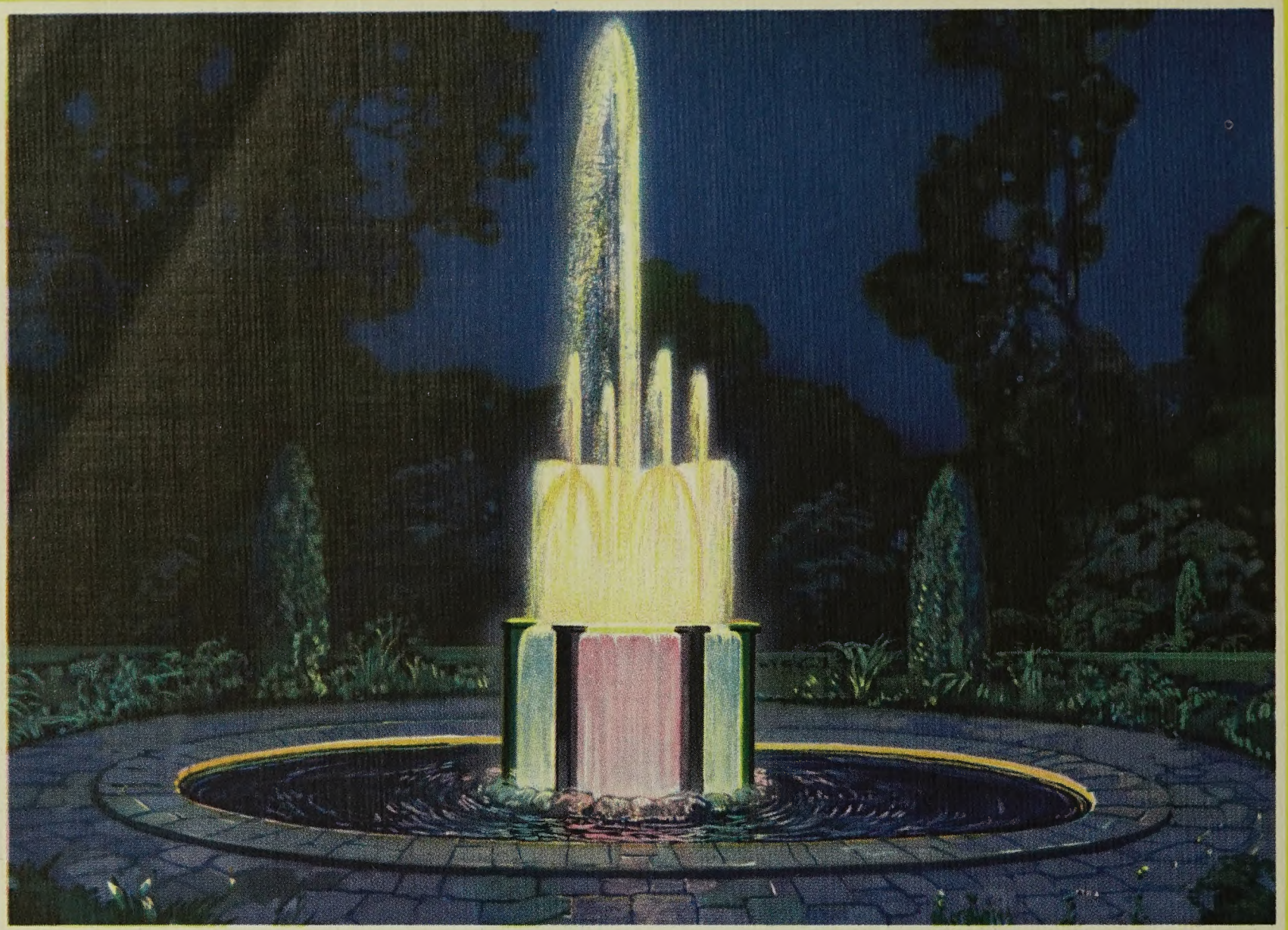
With the water cycle shown on the diagram, the pump circulates an average of 50 gallons per minute, although its capacity is sufficient to operate all the water effects continuously. Approximately 85 gpm. are required when all three displays are on together.

**Lighting**—Floodlights with 250-watt lamps are submerged in the basin and equipped with amber, red, and green color lenses, illuminating the water display. Lights with 60-watt lamps and amber, red and green color globes are mounted under the crest of the basin, illuminating the overflow and the spray from the rocks below. The two groups of lights are operated in a cycle of 18 ten-second periods, one color or a combination of two being used in each period.

**Water and Color Cycle**—The complete cycle of effects is 21 minutes in length, during which time 126 different combinations of color and water form occur.

**Power Consumption**—The average power consumption of the fountain is only about 3.0 kilowatts during the day and 4.7 kilowatts during the night when the lights are turned on.





Aqualux Basin-Pool type fountain designed especially for parks, institutions, and large estates—provides an elaborate display of water and color lighting effects.

# Aqualux Basin-Pool Type Fountain

THE equipment supplied for an Aqualux Basin-Pool type fountain consists of lights, basin crests, nozzles, rings of small jets, straight sections of small jets, strainer for suction line, float valve, cable entrance box, pump and motor, solenoid valves, motor starter, lighting contactor, remote-control station and flasher. The contractor builds the masonry, installs the equipment and supplies the standard pipe and fittings and miscellaneous electrical items.

**Basin and Pool**—The fountain consists of a raised octagonal center basin placed in a shallow pool 40 feet or more across. The water overflows from the basin into the pool below, from which it is circulated by the pump through the fountain.

**Vault**—The pump, flasher, valves, and contactors are placed in a vault located directly under the basin. Inasmuch as the operation of the fountain apparatus is by remote control from any convenient point, or by automatic time switch, it is unnecessary to enter the vault except for periodic inspection of the equipment.

**Water Effects**—The water display consists of four different effects—

(1) A main center jet projecting to a height of 30 feet or more.
(2) A group of four 2-foot diameter cylinders.
(3) A group of four jets or sprays in the center of each cylinder.
(4) A group of four radial vertical curtains of water projecting 8 feet.

The flasher automatically operates the solenoid valves in a cycle of seven one-minute periods, one or more of the four water effects

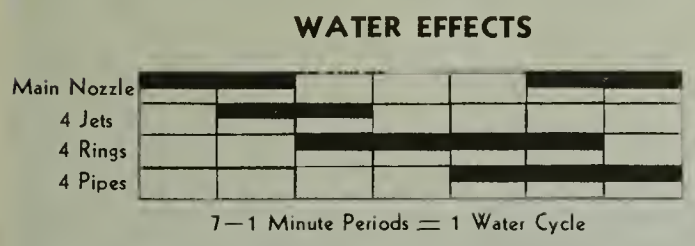
being on during each period. With the cycle shown on the diagram, the pump circulates an average of 85 gpm., although its capacity is sufficient to operate all the water effects.

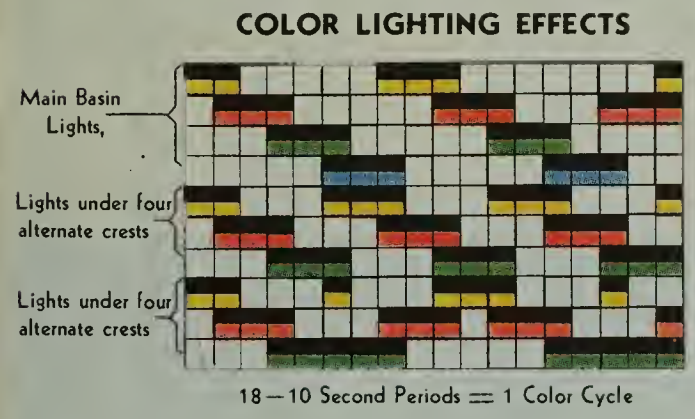
**Lighting**—Type CF-14 Aqualux floodlights with 500-watt, 1000-watt and 1500-watt lamps are submerged in the basin and equipped with amber, red, green and blue color lenses, illuminating the water display. Lights with 60-watt lamps and color globes are mounted under the crest of the basin, illuminating the overflow and the spray from the rocks below.

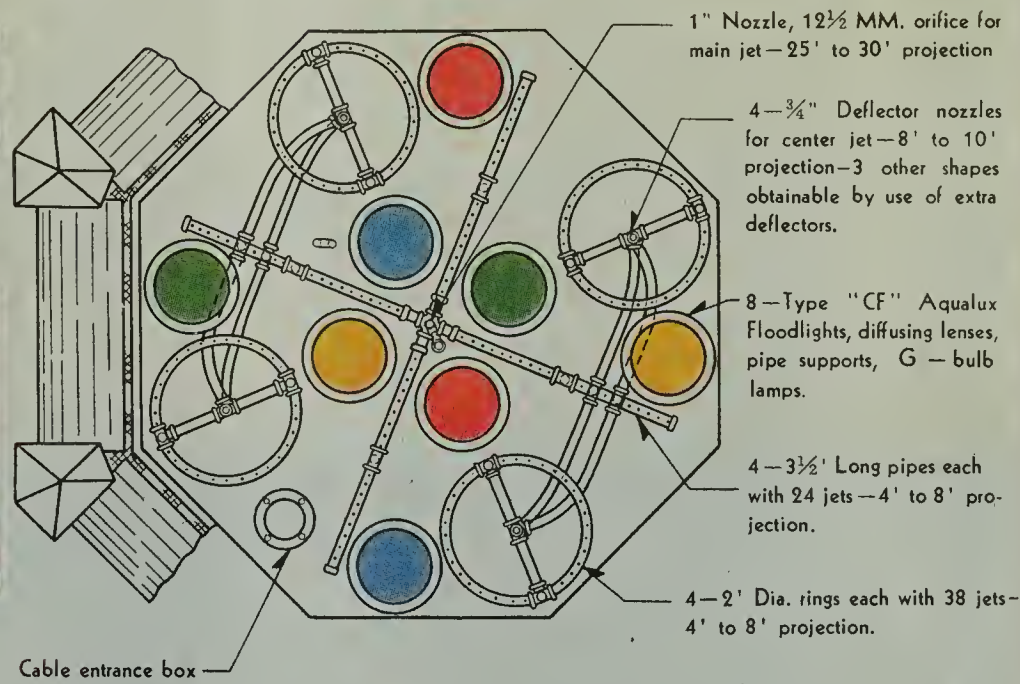
**Water and Color Cycle**—The complete cycle of effects is 21 minutes in length, during which time 126 different combinations of colors and water form occur—an apparently endless panorama of gracefully changing designs tinted with color.

**Power Consumption**—The average power consumption of the fountain is about 3.5 kilowatts during the day and 8.7 kilowatts during the night, when the lights are turned on.

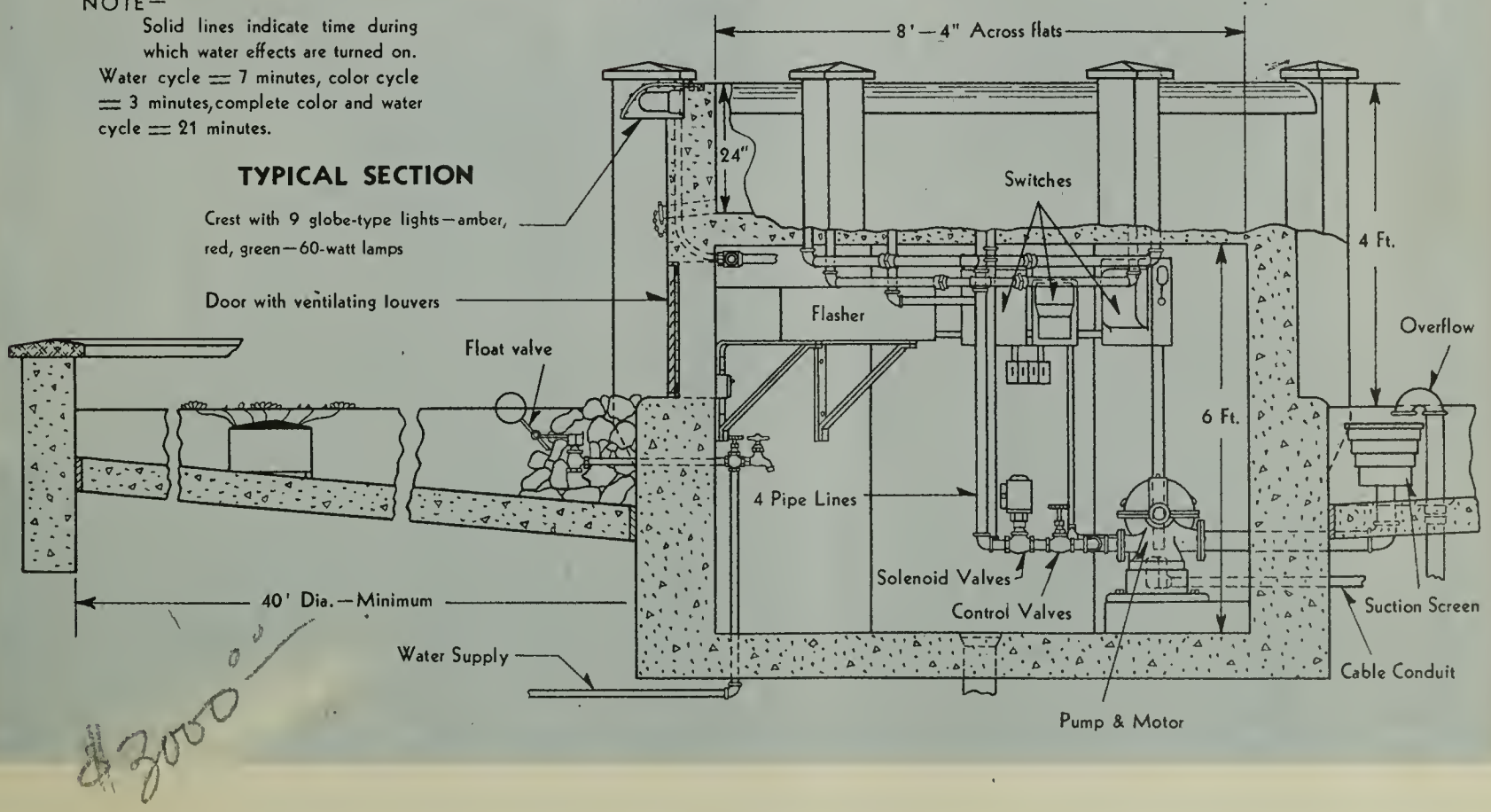
**Thermionic and Resistance Dimmer**—A color cycle having essentially the same characteristics as that shown below may also be obtained by substituting a Thermionic control or a special resistance dimmer for the flasher ordinarily supplied. Either system may be designed to operate the lighting on from four to ten different circuits.




NOTE—
Solid lines indicate time during which water effects are turned on.
Water cycle = 7 minutes, color cycle = 3 minutes, complete color and water cycle = 21 minutes.



# FOUNTAIN LIGHTING EQUIPMENT

Type CF-16 Aqualux Floodlight with floor flange base.

The Type CF-16 underwater floodlight is a 16-inch unit designed for use with 1000-watt or 1500-watt G-bulb floodlight lamps. It is especially suitable for lighting large fountains where long throws or high intensities are required.

The Type CF-14 underwater floodlight is a 14-inch unit designed for use with 500-watt or 1000-watt G-bulb floodlight lamps. This type of unit is used in the basin of the Aqualux Basin-Pool Type Fountain.

In either type of unit, all exposed metal parts are of non-corrosive materials. Rubber gaskets make the unit watertight, requiring neither drainage nor ventilation. The cable connection is made by either rubber cable through a packing gland or lead-encased cable through a lead-wiped joint. The body is mounted on a bow, which may be supported by one of several methods; floor flange base, servicing stand, pipe clamp or flat base. Color lenses are mounted inside the clear glass door lens. The reflector is either mirrored glass or chromium plated metal.

Type CF-14 Aqualux Floodlight with servicing stand.

Type WF-8 Aqualux Floodlight with support legs.

The Type WF-8 underwater floodlight is an 8-inch unit in a cubical housing, designed for use with 250-watt or 400-watt G-bulb floodlight lamps. This type of unit is used in the Aqualux Pond Type and Pedestal Type Fountains.

All exposed metal parts are of non-corrosive materials. Rubber gaskets make the unit watertight, requiring neither drainage nor ventilation. A single lens is used, either clear or colored. The reflector is either mirrored glass or chromium plated metal.

Type GF Aqualux Globe Type Floodlight.

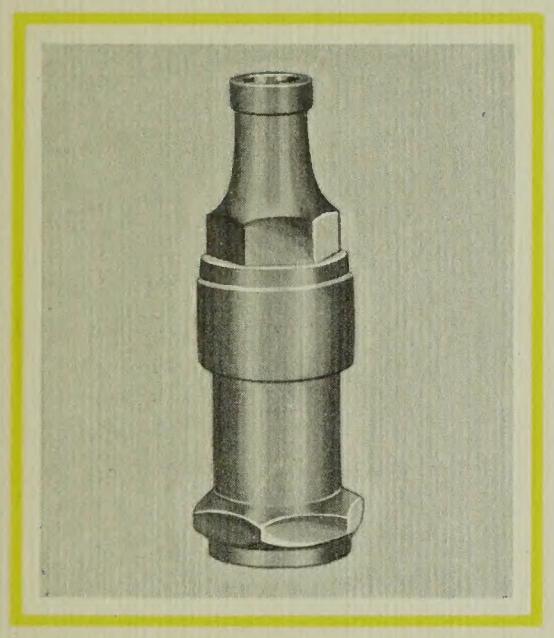
Type GFS Aqualux Globe Type Floodlight.

The Submersible Globe Type lights are designed for use with 150-watt or smaller general service lamps, for the illumination of small water displays or pools.

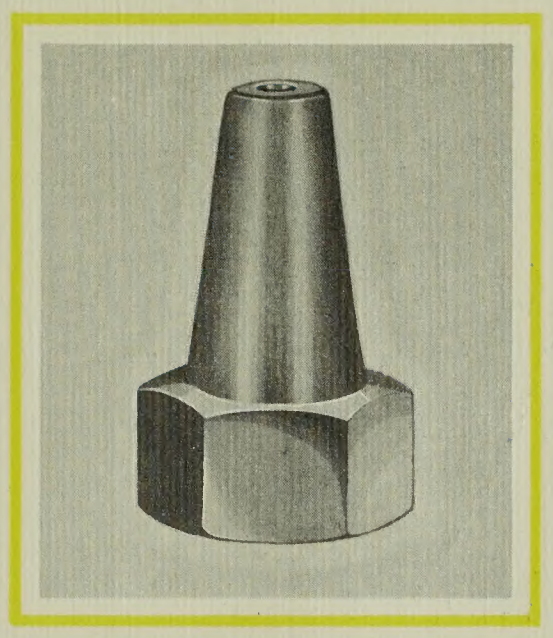
Both types of units illustrated consist of a cast bronze body and globe ring which are threaded, permitting the ring to be screwed down against a flange on the globe. Rubber gaskets between the globe and the body and between the globe and the ring make the joints watertight. Plain or colored globes may be used.

The Type GF fixture is equipped with an internal semi-cylindrical reflector. In the type GFS unit, which is smaller in size, no reflector is provided. This type has side outlets in the body, and mounting lugs.

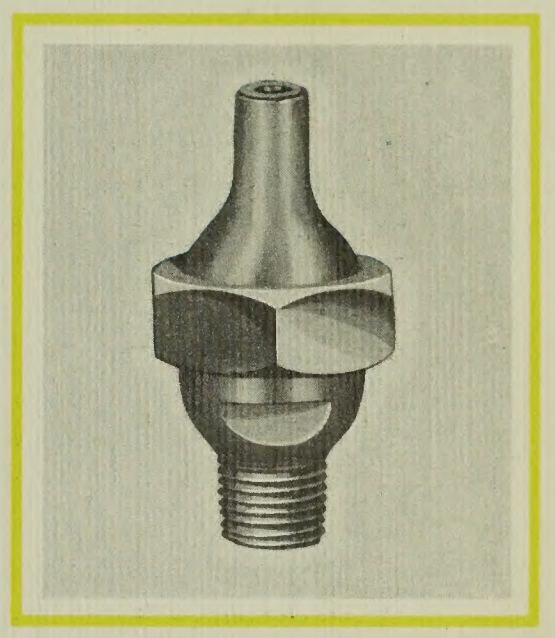
# FOUNTAIN HYDRAULIC EQUIPMENT



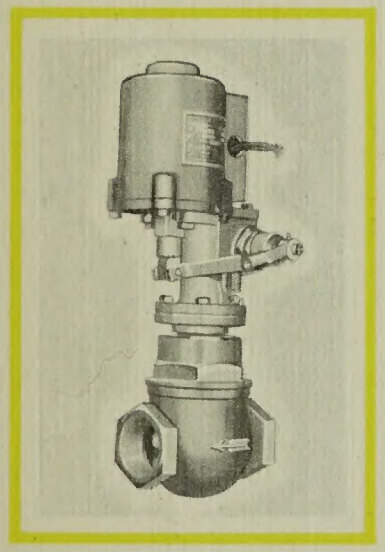
Standard spray nozzle with removable internal spiral.



Smooth-bore nozzle for producing solid jet.

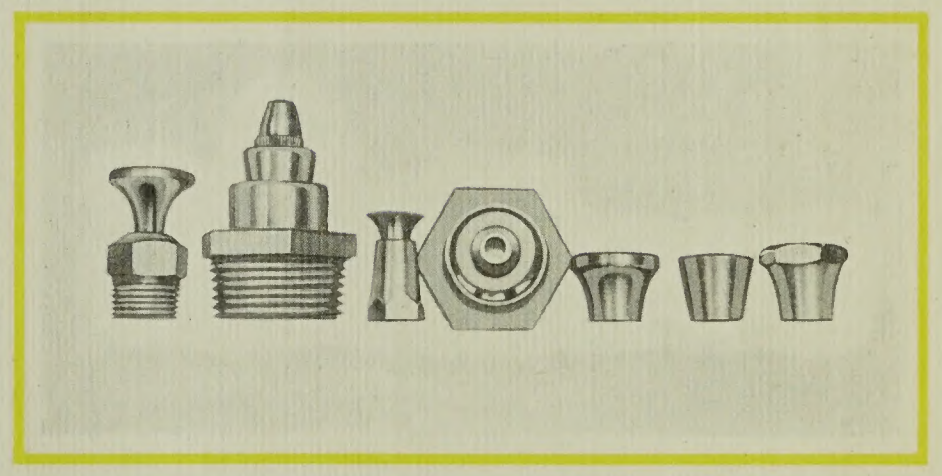


Adjustable socket nozzle for producing large solid jet.

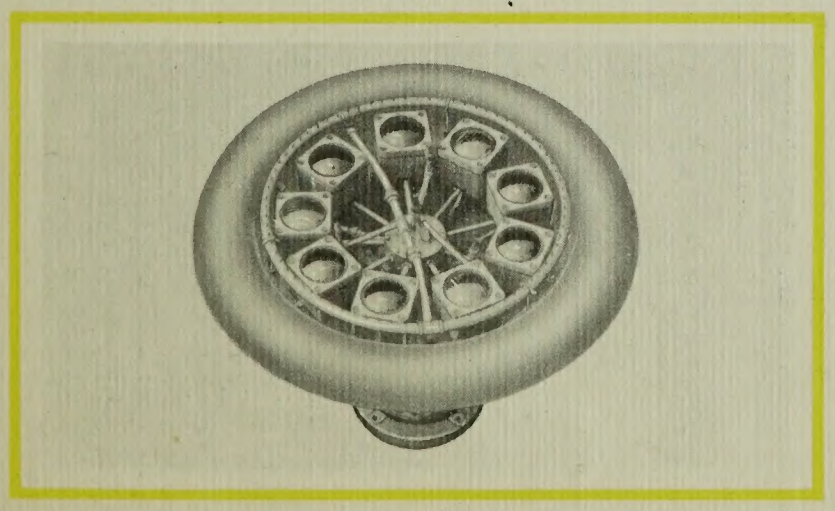


Illustrated at the right is a group of deflector-type nozzles with extra removable deflectors. A variety of spray shapes is thus obtainable with one nozzle.

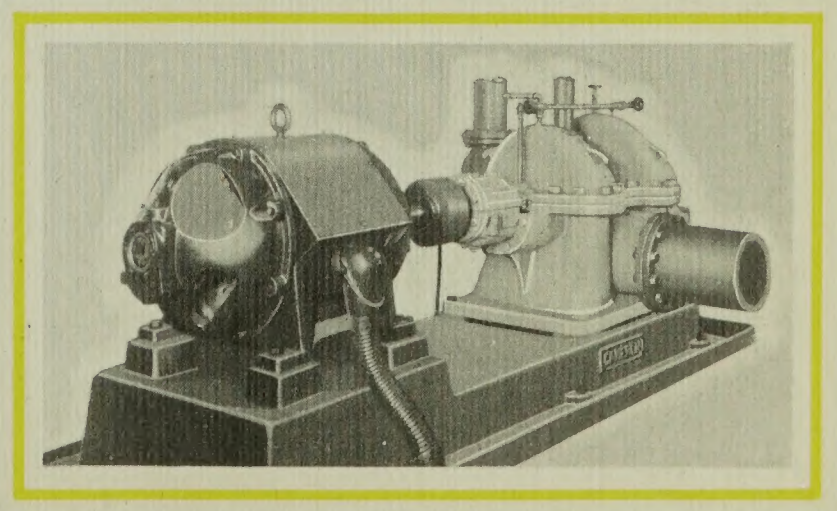
Illustrated at the left is a solenoid-operated water valve, one of which is placed in each feed line to produce a cycle of mobile water displays.



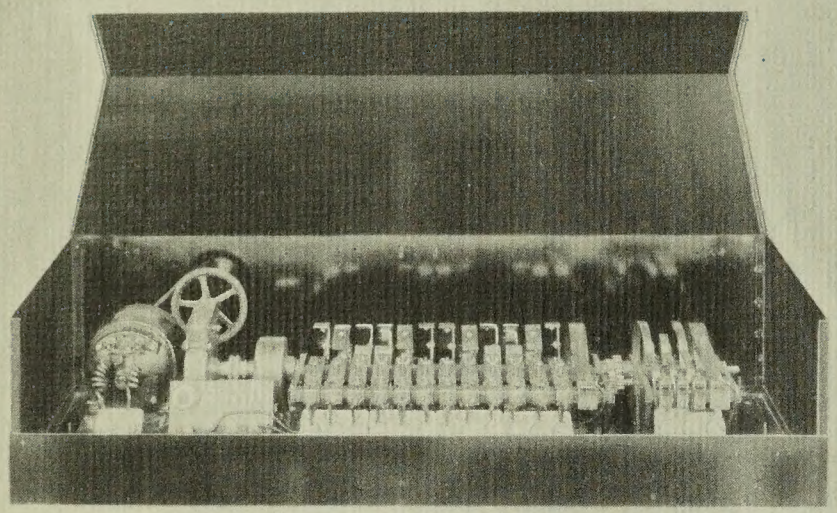
View of equipment in basin of the Aqualux Pedestal Type fountain, showing the center nozzle, the group of three spray nozzles, and the ring of jets.



Centrifugal pump direct-connected to motor. Correct size of pump and motor is obtained from performance curves.



# CONTROL OF MOBILE COLOR LIGHTING



Typical motor-driven flasher for the control of twelve lighting circuits and three water valves.

THE introduction of changing color into fountain lighting greatly enhances the effectiveness of the display, as indicated by the crowds of spectators gathering at night where one of these ever-changing color displays is in operation.

The automatic sequence of color blends can be obtained by four general methods:

1. Motor-driven Flasher.
2. Motor-driven Resistance Dimmer.
3. Reactance Dimmer with resistance plate control.
4. Reactance Dimmer with Thermionic Tube control.

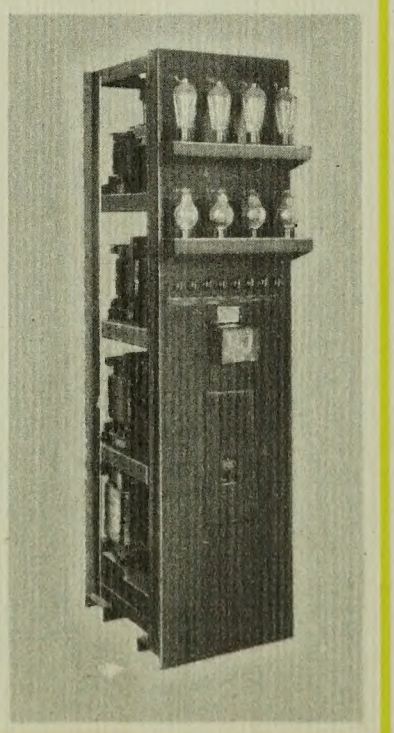
The relative first costs of each system increase in the order named.

### Motor-Driven Flasher

A flasher is the simplest and least expensive of the control methods, consisting of a small motor with a speed reducer, driving a shaft to which a number of sector wheels are attached, one for each circuit to be controlled. Each wheel has a stationary brush, to which the lighting circuits are connected. The other side of the supply line is connected to the rotating sectors through one or more feeder rings. The desired "on" and "off" sequence of each circuit is obtained by adjusting the separate sectors of each wheel.

While the first cost and maintenance of the flasher are low, it is obvious that no dimming effect is possible, the lights being either "full on" or "black out." The changes from one color to another are therefore abrupt. This effect may be minimized by dividing the lights of any one color among two or more circuits and slightly staggering the flasher sectors. The color then appears and disappears in two or more steps.

Thermionic Dimmer Panel for four circuits, showing the tubes and adjusters on the front and the reactors behind the panel.



### Motor-Driven Resistance Dimmer

The resistance dimmer method consists essentially of a rheostat in series with the lighting load to be controlled, the amount of resistance in the circuit determining the brightness of the light. Although higher in cost than the flasher method of control, it has the advantage of producing gradual changes in intensity.

The dimmer illustrated has an adjustable cam drive, permitting changes to be made in the color cycle. One type of cam moves the contact arm from bright to dim, or from dim to bright, in 1/6 of a cycle (60°), leaving 240 degrees to be divided in any desired proportion between full on and black out. Another accomplishes this in 1/4 of a cycle (90°), leaving 180 degrees to be divided between full on and black out. The time for a complete cycle can be varied by changing the relative size of the driving sprockets.

The drive consists of two cam surfaces mounted on the same shaft; one surface, operating on a roller follower, moves the contact arm from the bright to the dim position. The other surface, operating on the same follower, moves the arm from the dim to the bright position. The relative positions of the two surfaces can be adjusted within the limits given.

The dimmer plates are available in various ratings. Where the wattage to be controlled exceeds the rating of a single plate, two or more may be used, each independently connected to a part of the load.

Although the cam drive is flexible from the standpoint of control and the variety of effects obtainable, even greater flexibility may be obtained by assembling a reversing motor with each color group. The motors are in turn controlled by a motor-operated flasher. There are two contacts on the flasher for each motor: one for operating the motor in one direction to move the dimmer from bright to dim, and one for the reverse operation. Limit switches stop the motor automatically when the dimmer contact arm reaches the last contact.

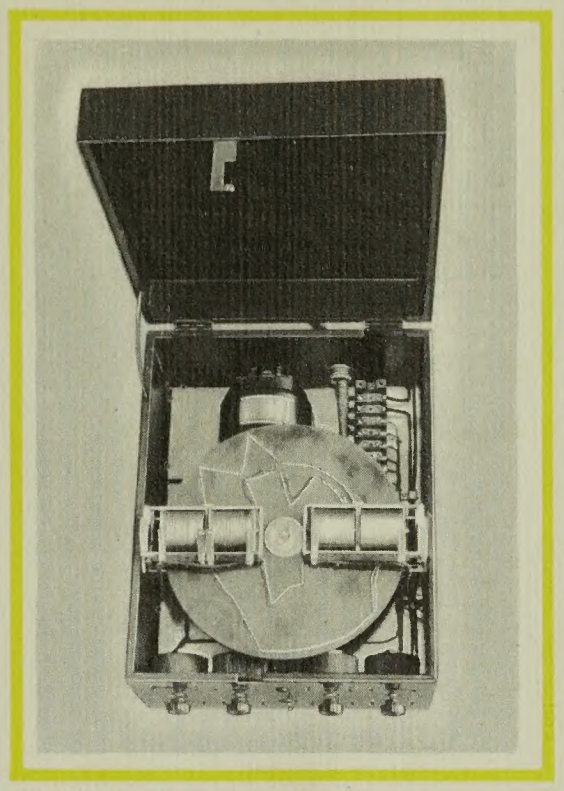
A great variety of color effects is possible with the individual motor drive, since the flasher contacts can be changed at intervals to produce a new cycle.

### Reactance Dimmer

When the load to be controlled is large, it becomes more economical to use the reactance type of dimmer.

The reactor used is the "three-legged" type, having the alternating-current load windings on the two outside legs and the direct-current control winding on the center leg. The dimming action is obtained as follows: When the control current is high, the iron is saturated, the a-c. circuit has only a small reactance, and full voltage is applied to the lamps. As the direct current is reduced, the iron saturation decreases and the a-c. winding reactance increases correspondingly, resulting in decreasing voltage on the lamps.

The direct current from any suitable source is varied by a motor driven resistance dimmer plate, which, however, need have only about one per cent of the capacity of the controlled lamp load. One dimmer plate and one reactor are required for each circuit to be controlled.



Control Unit for a Disc Type Thermionic system.

The point at which reactance dimmers become more economical than resistance dimmer plates is not definite, and can only be determined by making a comparison for each proposed installation. If a load is sufficiently large to warrant the use of reactors from the standpoint of cost, the following advantages also accrue:

1. Higher efficiency.
2. Absence of large moving parts.
3. Absence of contacts in the load circuit.
4. Flexibility of operation and installation.

### Thermionic System

The reactance dimmer method, using a dimmer plate in the direct-current control circuit, is limited somewhat in flexibility by the gears and cams through which the motor transmits its power. To provide an ultra-flexible control, the electronic tube has been applied with the necessary accessory apparatus to two types of a system known generally as the "Thermionic Tube Control".

The load circuit is controlled through reactors as discussed above. The Thermionic system is therefore exclusively a control circuit, taking part only in the supply and regulation of direct current to the reactor control winding. Any type of Thermionic control has two parts in common:

1. Reactance-type dimmers, employing the three-legged reactor with two separate windings; the alternating-current load winding, to which the lamp load for each circuit is connected, and the direct-current control winding.
2. An electronic tube unit, which is a controllable rectifier receiving its power from the alternating-current service, rectifying it, and impressing it upon the direct-current coil of the reactor. The output of the tube unit directly controls the load voltage of the reactors and the dimming of the lamp load.

This much of the system is the same for any kind of Thermionic control. The types are differentiated by the method of varying the output of the tube unit, and are classified as film type or disc type.

**Film-Type Control**—By the film control, lighting effects are obtained in any combination of intensities, in any sequence, and at any rate of change. It is ultra-flexible, always insures a definite predetermined program, and is unlimited in number of units.

This control derives its name from the moving potentiometer contact, connected to the grid of the tube unit, which is in the form of a metal conducting braid attached to a 70-mm. moving-picture film. Each circuit to be controlled requires a separate film, and the spools of all circuits are synchronized mechanically.

The control potentiometer itself consists of a wire-wound resistor mounted on a spindle directly above the film. The potential picked up by a conducting braid on the film passing under a potentiometer will depend on the lateral position of the braid on the film. For instance, a straight run of braid along one side of the film will produce full intensity in the lighting circuit, and if the braid gradually slopes toward the opposite side of the film, the lighting circuit is dimmed when that part of the braid passes under the potentiometer. The rate of change in intensity can be made gradual or rapid, to a minimum of about three seconds from full bright to black out.

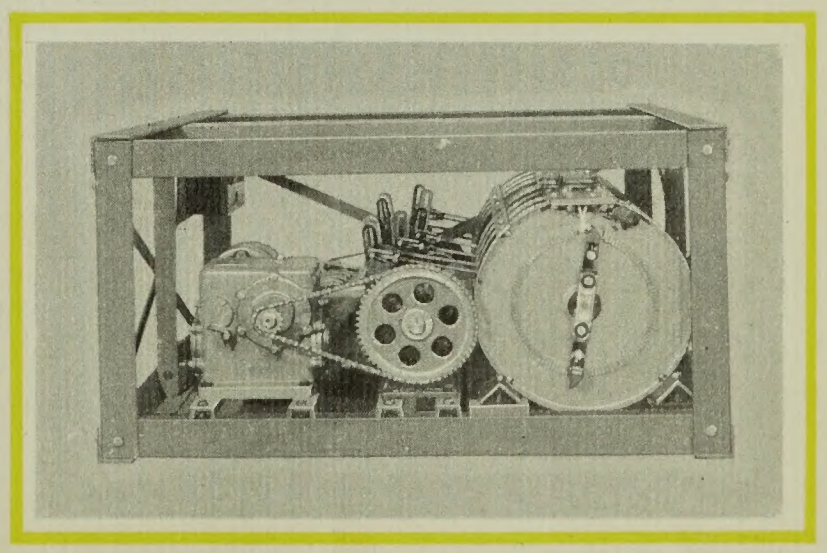
The films are removable; they can be interchanged between different circuits. Reserve films can be kept to provide an altogether different cycle. This system is, therefore, particularly suitable for involved control schemes in which the limitations in flexibility of other systems would make it difficult or impossible to obtain the desired effects.

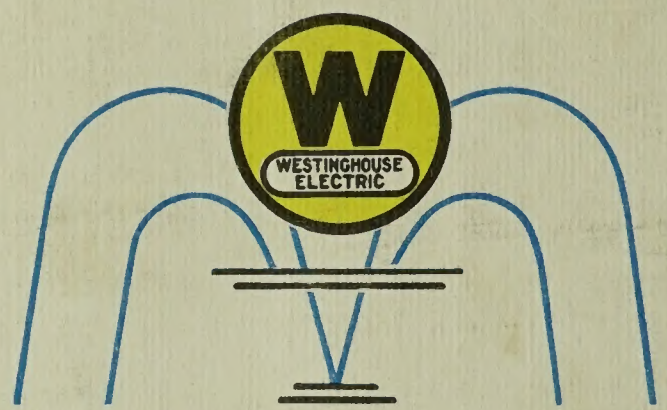
**Disc-Type Control**—The circuits and operation of the disc control are similar to the film type; the difference is in the arrangement of the potentiometers and conducting braid. The braid is laid out on a motor-driven disc similar to a phonograph record. Two separate braids are placed on each disc, and two discs, back to back, form a complete unit for the control of four circuits.

The potentiometer pick-up rollers are mounted in pairs on horizontal shafts, one shaft below the lower disc in contact with its two conducting tracks, and another shaft mounted above the upper disc, in contact with its two conducting tracks.

The arrangement of circuits with respect to the potentiometers and tube units is the same as for the film-type control. The variation of intensity in the controlled lighting circuit is determined by the pattern formed by the conducting braid on the disc and its position with respect to the potentiometer pick-up roller. Different records may be quickly substituted.

Eight-plate, cam-drive resistance plate dimmer assembled on steel frame.





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